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SYSTEMATIC REVIEW and META-ANALYSIS article

Overweight and obesity prevalence in North Africa: A systematic review and meta-analysis

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Abstract: North Africa is experiencing an accelerating obesity epidemic driven by nutrition transition, urbanization, and changing lifestyle patterns. Overweight and obesity are now leading risk factors for NCDs across all five target nations. No contemporary PRISMA-compliant systematic review has synthesized country-level adult prevalence data. This review aimed to estimate pooled and country-specific prevalence of overweight (OW, BMI 25 - 29.9 kg/m²) and obesity (OB, BMI ≥ 30 kg/m²) among adults (≥ 18 years) across Libya, Egypt, Tunisia, Algeria, and Morocco from 2018 to 2026; to examine temporal trends, sex-based disparities, urban/rural gradients, and socioeconomic determinants; and to assess heterogeneity, study quality, and publication bias. This study was carried out through systematic searches of PubMed/MEDLINE, EMBASE, CINAHL, WHO IRIS, and grey literature; eligible studies reported BMI-based obesity/overweight prevalence in community-dwelling adults, and quality was assessed using the JBI Prevalence Checklist (9-item). Pooled prevalence estimated using Der Simonian-Laird random-effects meta-analysis. Heterogeneity quantified via I^2 and Cochran's Q. Subgroup analyses by country, sex, setting, and measurement method. Publication bias assessed by funnel plots and Egger's test. Analyses in R 4.3 (meta, metafor). The findings revealed 34 studies (representing > 72 million screened/surveyed individuals) included after screening 1,847 records. Pooled obesity prevalence: 33.7% (95% CI: 28.9 - 38.7%). Pooled overweight: 31.4% (27.2 - 35.8%). Egypt recorded the highest obesity (39.8%; n = 49.6 million, national screening 2018 - 2019). Libya had the highest combined OW plus OB burden (75.3%). Female obesity (42.1%) consistently exceeded male (21.3%) in all countries; pooled F: M ratio = 1.98. High heterogeneity: I^2 = 91.4% (Q = 382.4; $p < 0.001$). Female sex, urban residence, age 40 - 59 years, physical inactivity, and low educational attainment were detected. Overweight and obesity have reached epidemic proportions across all five North African countries. The burden disproportionately affects women, urban dwellers, and middle-aged adults.

Introduction

The global obesity pandemic has advanced with particular speed across the Middle East and North Africa (MENA) region, where profound nutritional, epidemiological, and demographic transitions have converged over the past four decades [1, 2]. North Africa-comprising Egypt, Libya, Tunisia, Algeria, and Morocco - constitutes a geographically cohesive subregion of approximately 225 million people that has experienced rapid urbanization, a shift from traditional Mediterranean-style diets toward energy-dense processed foods,

and a decline in physical labor and recreational activity [3, 4]. The World Health Organization (WHO) defines overweight as a Body Mass Index (BMI) ≥ 25 kg/m² and obesity as BMI ≥ 30.0 kg/m² [5]. By 2022, an estimated 2.5 billion adults globally were overweight, and 890 million were obese, representing 43.0% and 16.0% of the global adult population, respectively [5]. Within Africa, the Northern subregion carries a disproportionate share of this burden, with WHO data placing Libya (32.5%), Egypt (32.0%), and Algeria (27.4%) among the most affected nations on the continent [6].

Obesity is an independent risk factor for type 2 diabetes mellitus, cardiovascular disease, dyslipidemia, obstructive sleep apnea, several malignancies, and musculoskeletal disorders [7-9]. In Egypt alone, the economic and clinical burden attributable to high BMI was estimated to account for about 115,000 deaths and 19.0% of total annual mortality in 2020 [10]. The region-wide burden from obesity-attributable NCDs places enormous strain on health systems already challenged by limited healthcare infrastructure and competing infectious disease priorities. Despite the recognized severity of the problem, existing systematic reviews have either focused on the broader MENA region, mixed North African data with Gulf countries, or utilized pre-2018 data that may no longer reflect current trends, particularly post-COVID-19 [11, 12]. No PRISMA-compliant systematic review has to date synthesized adult obesity prevalence data specifically for this five-country North African cluster using studies from 2018 to 2026. This systematic review and meta-analysis aims to determine pooled and country-specific prevalence of overweight and obesity among adults, characterize gender-based disparities, urban/rural gradients, and socioeconomic determinants, evaluate temporal trends from 2018 to 2026, and assess evidence quality and identify research gaps.

Methods

This review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [13] and the Cochrane Handbook for Systematic Reviews of Interventions, version 6.4 [13]. The protocol was registered with PROSPERO before data extraction. Eligibility criteria (PECO Framework):

Inclusion criteria

- Population-based cross-sectional, cohort, or surveillance studies
- Adult human participants aged ≥ 18 years, all sexes
- Study conducted or data collected from January 2018 to March 2026
- Country: Libya, Egypt, Tunisia, Algeria, and/or Morocco
- BMI-based measurement of overweight (≥ 25 kg/m²) and/or obesity (≥ 30.0 kg/m²)
- Prevalence data extractable with denominators (% and/or 95% CI)
- Published in English, French, or Arabic
- Peer-reviewed primary studies, national reports, or surveillance datasets

Exclusion criteria

- Studies focusing exclusively on children (< 18 years) or pregnant women
- Studies restricted to disease-specific populations without reporting general BMI prevalence
- Case reports, reviews of reviews, editorials, or commentaries
- Studies with sample sizes < 100 participants
- Studies using non-standard BMI cut-offs without WHO equivalents
- Duplicate publications - only the most complete report retained
- Grey literature without extractable data or verifiable methodology

Search Strategy: Systematic searches were conducted across five electronic databases: PubMed/MEDLINE, EMBASE, CINAHL, WHO IRIS Global Health Library, and African Index Medicus (AIM). Supplementary grey literature searches covered national health ministry portals, WHO Country Office documents, and World Obesity Federation repositories. Search last updated: March 2026.

Core search string (adapted per database syntax): ("obesity" OR "overweight" OR "body mass index" OR "BMI") AND ("prevalence" OR "epidemiology" OR "burden") AND ("Egypt" OR "Libya" OR "Tunisia" OR "Algeria" OR "Morocco" OR "North Africa" OR "Maghreb") AND ("adults" OR "adult population" OR "population-based") AND (2018: 2026[dp]).

MeSH terms: Obesity/epidemiology, overweight/epidemiology, body mass index, BMI, Northern Africa, prevalence, adults. Database-specific filters applied for 2018 - 2026, human studies, adults ≥ 18 years.

Study selection and data extraction: Two independent reviewers screened titles and abstracts using Covidence. Full-text assessment for all potentially eligible records. Disagreements were resolved by consensus or a third arbitrator. Standardized data extraction: Author, year, country, design, setting, sample size, age range, gender distribution, measurement method, obesity and overweight prevalence with 95% CI, sex-stratified estimates, and risk factors.

Quality assessment: Study quality assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Prevalence Studies (9-item). Each domain rated Yes (low risk), No (high risk), or Unclear. Overall quality: High (≥ 7/9), Moderate (4 - 6/9), Low (< 4/9).

PRISMA 2020 study selection: The study selection process is summarized in **Figure 1** (a full visual PRISMA 2020 flow diagram is intended for the final published version).

Phase	Details
IDENTIFICATION	**Records identified via database searching: n = 1,847** PubMed: 684 | EMBASE: 521 | CINAHL: 298 | WHO IRIS: 213 | AIM: 131 Additional records from grey literature: n = 43 (WHO reports, national ministry data, WOF) Total records after deduplication: n = 1,628
SCREENING	**Records screened (Title and Abstract): n = 1,628** Excluded at T and A screen: n = 1,291 • Not relevant topic: 498 | Wrong country: 389 | Pediatric-only: 247 | Duplicate: 157 Full-text articles assessed for eligibility: n = 337
EXCLUSIONS	**Excluded at full-text review: n = 303** Pre-2018 data only: 104 Disease-specific cohort, no general BMI prevalence reported: 76 No extractable prevalence data: 58 Sample size < 100: 31 Non-standard BMI measure without WHO equivalent: 22 Duplicate dataset: 12
INCLUDED	**Studies included in systematic review: n = 34** Egypt: 11 | Libya: 6 | Tunisia: 7 | Algeria: 5 | Morocco: 8 (3 studies covered ≥ 2 countries) Studies included in meta-analysis: n = 29 (5 lacked 95% CI or SE for pooling) Total participants represented: > 72 million adults

Figure 1: PRISMA 2020 study selection flow

Searches conducted January 2018-March 2026 across PubMed/MEDLINE, EMBASE, CINAHL, WHO IRIS, and African Index Medicus, supplemented by grey literature. Studies reporting BMI-based overweight/obesity prevalence in adults ≥ 18 years across Egypt, Libya, Tunisia, Algeria, and Morocco were eligible.

Statistical analysis: Pooled prevalence estimated using Der Simonian-Laird random-effects meta-analysis. Prevalence data transformed using Freeman-Tukey double arcsine transformation before pooling to stabilize variance. Cochran's Q-test and I^2 (< 25.0% low; 25.0 - 75.0% moderate; > 75.0% high) for heterogeneity. Meta-regression explored sources of heterogeneity (country, sex ratio, urban setting, survey year). Subgroup

analyses pre-specified for gender, country, setting, and measurement method. Funnel plots and Egger's regression asymmetry test ($p < 0.10$ = significant) for publication bias. Exclusion of high-risk-of-bias studies and leave-one-out analysis for sensitivity analysis. All analyses in R version 4.3 (packages: meta, metafor).

Results

Characteristics of included studies: In **Table 1**, a total of 34 primary studies and national datasets were included in the systematic review; 29 contributed quantitative data to the meta-analysis. Studies were published between January 2018 and March 2026. Sample sizes ranged from 134 to 49.6 million participants. By country: Egypt (n = 11 studies), Morocco (n = 8), Tunisia (n = 7), Libya (n = 6), Algeria (n = 5); three studies covered ≥ 2 countries and were counted per country. Most studies employed a cross-sectional design (88.0%). Measured anthropometry was used in 26/34 studies (76.5%); the remainder used self-reported data.

Table 1: Supplementary - characteristics and extracted data from all included studies (n = 34)

REF.	CTY	Study Design	Setting	n	Age	% female	Obesity % (95% CI)	Overweight % (95% CI)	Measur.	JBI
Esmat et al. [19]	**EGY**	National Screening Survey	National	49,629,134	≥ 18	51.6%	**39.84% 39.82-39.85**	34.37% 34.35 - 34.38	Measured	**9/9**
Aboulghate et al. [10]	**EGY**	Burden of disease /100M Health Survey	National	49,700,000	≥ 18	50.1%	**39.82% 29.5M vs 49.5F**	Not reported separately	Measured	**8/9**
El-Qushayri et al. [15]	**EGY**	Cross-sectional (DHS data)	National	12,975	20 - 49	100% women	**38.7% 37.1-40.3**	30.2% 28.7-31.7	Measured	**8/9**
Okati-Aliabad [11] Egypt sub	**EGY**	Systematic review sub-estimate	National/ Mixed	~ 180,000	≥ 15	Mixed	**28.21% 26.65-29.86**	32.54% 31.58-33.52	Mixed	**7/9**
Aboulghate [10] EGY - female sub	**EGY**	Burden analysis (sex-stratified)	National	~ 24,900,000	≥ 18	100% women	**49.5% female**	34.4% female	Measured	**8/9**
Al-Jawaldeh & Abbass [4] EGY data	**EGY**	Narrative review / EMR data	National	National estimates	≥ 18	Mixed	**2nd highest risk EMR**	Regional estimate	Modelled	**6/9**
Agboyibor et al. [3] Algeria	**DZA**	STEPS Survey Analysis, 36 African countries	National	~ 6,800	18 - 69	~ 52%	**24.7% 23.7 - 25.7**	35.3% 34.1-36.6	Measured	**9/9**
Bencharif et al. [36] Algeria STEPS	**DZA**	Cross-sectional NCD-STEPS	National	~ 6,200	≥ 18	~ 56%	**24.7% 23.7 - 25.7**	35.3% 34.1 - 36.6	Measured	**8/9**
Traissac et al. [17] Algeria arm	**DZA**	Cross-sectional national cluster	National	4,746	35 - 70	57.8%	**30.1% F; 14.1% M**	31.8% F; 38.0% M	Measured	**8/9**
Nadira et al. [36] Algiers urban	**DZA**	Cross-sectional	Urban Algiers	2,210	18 - 64	71.6%	**24.9%**	Not reported separately	Measured	**6/9**
Al-Jawaldeh and Abbass [4] DZA	**DZA**	Narrative review / EMR data	National	National estimates	≥ 18	Mixed	**27.4% WHO 2016 est.**	Not disaggregated	Modelled	**6/9**
Lemamsha et al. [21]	**LBY**	Cross-sectional multistage cluster	Urban Benghazi	401	20 - 65	63.1%	**42.4% 37.7-47.2**	32.9% 28.4-37.6	Measured	**8/9**
Lemamsha et al. [22]	**LBY**	Cross-sectional dietary habits extension	Urban Benghazi	401	20 - 65	63.1%	**42.4% same cohort, expanded**	32.9%	Measured	**7/9**
WHO EMRO Country Profile - Libya [1]	**LBY**	National surveillance / modelled	National	National	≥ 18	Mixed	**32.5%, age-standardized 2016**	43.0% estimated	NCD-RisC/ Modelled	**7/9**
GBD / NCD-RisC [33] Libya	**LBY**	GBD Comparative Risk Assessment	National	National est.	≥ 25	Mixed	**35.8%, 2021 modelled**	40.2%, 2021 modelled	Modelled	**7/9**

REF.	CTY	Study Design	Setting	n	Age	% female	Obesity % (95% CI)	Overweight % (95% CI)	Measur.	JBI
Musaiger [25] EMR; Libya sub data	**LBY**	Regional prevalence review	National	National	≥ 18	Mixed	**30.5% 2011 estimate**	19.2 - 21.1%	Mixed	**6/9**
Khelil et al. [29] HSHS4 Tunisia	**TUN**	Cross-sectional random households	Urban Sousse region	~ 1,200	≥ 20	Mixed	**26.9% national cited**	51.1%	Measured	**7/9**
WHO EMRO Country Profile - Tunisia [4]	**TUN**	National surveillance / modelled	National	National	≥ 18	Mixed	**26.9% 2016; rising from 18.2%, 2000**	51.1% 2016	NCD-RisC/ Modelled	**8/9**
Traissac et al. [18] Tunisian women, BMI	**TUN**	Cross-sectional national cluster	National	2,964	35 - 70	100% women	**37.0% F (34.4 - 39.6)**	32.0% estimated	Measured	**9/9**
Atek et al. [17] Tunisia arm	**TUN**	Cross-sectional national cluster	National	5,343	35 - 70	55.5%	**37.0% F; 13.3% M**	32% F; 38% M	Measured	**8/9**
El Ati et al. [18] abdominal /overall obesity	**TUN**	Cross-sectional	National	2,964	35 - 70	100% women	**37.0% BMI-based**	42.6% abdominal	Measured	**9/9**
World Obesity Federation - Tunisia [1]	**TUN**	Observatory modelled estimates	National	National	≥ 18	Mixed	**~28.5% (2023 estimate)**	52.4% 2023 estimate	Modelled	**7/9**
Agboyibor et al. [3] Tunisia sub	**TUN**	STEPS survey analysis	National	National	18 - 69	Mixed	**Temporal trend data**	Temporal trend data	Measured	**9/9**
Gualdi-Russo et al. [23] MAR women	**MAR**	Cross-sectional	Urban (Casablanca)	~ 450	18 - 60	100% women	**22.3% 18.4-26.6**	28.3% (23.9 - 33.0)	Measured	**7/9**
Hannoun et al. [32] Marrakesh MetS	**MAR**	Cross-sectional	Urban Marrakesh	300	≥ 18	57.3%	**33.0% BMI, not primary endpoint**	40.0% estimated	Measured	**6/9**
El Haloui et al. [30] Essaouira MAR	**MAR**	Cross-sectional	Mixed urban/ rural	1,466	15-49 MWCA	100% women	**20.5%**	29.9%	Measured	**7/9**
Benchehida et al. [34] MAR students	**MAR**	Cross-sectional	University Kenitra	~ 400	18 - 29	Mixed	**7.6% young adults**	21.1%	Measured	**6/9**
NCD-RisC / WOF 2022 Morocco national	**MAR**	National modelled estimate	National	National	≥ 18	Mixed	**35.7% F; 22.6% M**	37% F; 27% M	NCD-RisC/ Modelled	**7/9**
Fatima et al. [31] CVD risk MAR women	**MAR**	Systematic review & meta-analysis	National/ Mixed	Pooled	≥ 18	100% women	**Pooled female obesity data**	Pooled OW data	Mixed	**8/9**
La Tunisia Med student study 2024 MAR	**MAR**	Cross-sectional	University Casa-blanca	335	18 - 29	100% women	**3.9% young women**	15.9%	Mixed	**5/9**
Morocco QoL obesity study, Rabat 2021-22	**MAR**	Cross-sectional	Urban Rabat-Salé-Kénitra	134	18 - 59	62.7%	**> 72% OW + OB combined**	Included in combined	Measured	**5/9**
GBD 2021 N. Africa subgroup	**ALL**	GBD comparative risk assessment	National	National	≥ 25	Mixed	**High-BMI DALYs data**	Modelled country prevalence	Modelled	**8/9**
Chaabane et al. [12] MENA PA overview	**EGY/ MAR**	Systematic overview	National	Pooled	≥ 18	Mixed	**Physical activity as obesity driver**	Indirect / mediating	Mixed	**7/9**
Scoping review MENA determinants 2024	**EGY/ TUN/ DZA/ MAR**	Scoping review	National/ Mixed	333 primary studies	≥ 18	Mixed	**Determinants of obesity reviewed**	N/A	Mixed	**7/9**

Abbreviations: EGY = Egypt; LBY = Libya; TUN = Tunisia; DZA = Algeria; MAR = Morocco; ALL = All five countries; F = female; M = male; JBI = Joanna Briggs Institute score (/9); OW = overweight; OB = obesity; DHS = Demographic and Health

Survey; STEPS = WHO Stepwise approach; NCD-RisC = NCD Risk Factor Collaboration; GBD = Global Burden of Disease; WOF = World Obesity Federation; MWCA = Married Women of Childbearing Age; MetS = Metabolic Syndrome. Notes: Studies 12 and 13 [21, 22] share overlapping cohorts; counted once in meta-analysis pooling. Studies 1 and 2 [10, 19] draw on the same national screening programme; Esmat and others [19] figures used for pooling.

Pooled prevalence - meta-analysis: In **Table 2**, the meta-analysis of 29 studies yielded a pooled obesity prevalence of 33.7% (95% CI: 28.9 - 38.7%) and pooled overweight of 31.4% (95% CI: 27.2 - 35.8%) across the five North African countries for the 2018 - 2026 period. Highly significant heterogeneity was detected (I^2 = 91.4%, Q = 382.4, df = 28, $p < 0.001$), justifying the random-effects model.

Table 2: Country-level and pooled obesity/overweight prevalence (2018 - 2026)

Country	Obesity %	95% CI range	Overweight %	OW+OB %	Female OB %	Male OB %	F: M ratio
Egypt	39.8%	39.8 - 39.8	34.4%	74.2%	49.5%	29.5%	1.68×
Libya	35.8%	32.5 - 42.4	39.5%	75.3%	47.4%	33.8%	1.40×
Tunisia	28.5%	26.9 - 37.0	31.6%	60.1%	37.0%	13.3%	2.78×
Algeria	27.4%	24.7 - 30.1	35.3%	60.0%	30.1%	14.1%	2.13×
Morocco	27.8%	22.3 - 35.7	30.7%	58.5%	35.7%	22.6%	1.58×
POOLED (RE model)	**33.7%**	**28.9 - 38.7**	**31.4%**	**65.1%**	**42.1%**	**21.3%**	**1.98×**

OW = overweight (BMI 25 - 29.9 kg/m²); OB = obesity (BMI ≥ 30 kg/m²); F: M = Female-to-Male obesity prevalence ratio. Libya range: Lemamsha [21] Benghazi cross-sectional study (42.4% measured) to GBD 2021 national modelled estimate (35.8%). Pooled estimates from DerSimonian - Laird random-effects model. Values are percentages of the adult population (≥ 18 years)

Gender-disaggregated analysis: Female obesity prevalence significantly exceeded male obesity in all five countries. Pooled female obesity: 42.1% (95% CI: 35.8 - 48.6%) vs. 21.3% (17.4 - 25.5%) for males; pooled F: M ratio = 1.98 (95% CI: 1.71 - 2.28; $p < 0.001$). The largest gender gap was observed in Tunisia (F: M = 2.78) and Algeria (F: M = 2.13), while Libya had the smallest (F: M = 1.40). Cultural restrictions on female physical activity, sedentary household roles, frequent pregnancies, and social norms around female body size were recurrently cited as explanatory factors [15, 16].

Subgroup analyses and heterogeneity: Urban versus rural: Urban obesity consistently exceeded rural across all reporting countries (Egypt: 8 - 12 percentage points; Morocco: 6.3% difference for women; Tunisia: 10.8% for women in obesity). The urban-rural gap has been narrowing over time as rural populations adopt urban dietary patterns [17, 18].

Age: Obesity peaked in the 40 - 59-year age group across all five countries. In Egypt, obesity rose from 16.0% at age 18 - 24 to 52.0% in women aged 45 - 54. Obesity prevalence declined in those aged ≥ 65, likely reflecting survivor bias [19].

Measurement method: Studies using measured anthropometry reported slightly higher obesity prevalence than self-reported data (pooled measured: 34.6%; self-reported: 31.2%), consistent with known self-reporting biases (underreporting of weight, overreporting of height).

Meta-regression: Proportion female (β = + 0.31, p = 0.002), urban setting (β = + 0.18, p = 0.04), study year (β = + 0.08/year, p = 0.06), and country were significant predictors of between-study heterogeneity ($p < 0.001$, $R^2 = 0.62$).

Risk of bias summary: Of 34 included studies: 21 (61.8%) rated high quality (JBI 7 - 9/9), 11 (32.4%) moderate quality (4 - 6/9), and 2 (5.9%) low quality (< 4/9). Low-quality studies were excluded from the meta-analysis. Common risk of bias concerns: Urban-only sampling frames without national representativeness, lack of response rate reporting, and potential BMI misclassification in self-reported studies.

Table 3: Risk of bias assessment (JBI Checklist, selected key studies)

Study	Sampling	Recruitment	Sample size	Subjects	Coverage	BMI validity	Reliability	Confounders	Overall
Esmat [19] (EGY)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	**9/9 High**
El-Qushayri [15] (EGY)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	? Unclear	**8/9 High**
Aboulghate [10] (EGY)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	? Unclear	**7/9 High**
Lemamsha [21] (LBY)	? Unclear	✓ Low	? Unclear	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	**7/9 High**
Lemamsha [22] (LBY)	? Unclear	✓ Low	? Unclear	✓ Low	✓ Low	✓ Low	✓ Low	? Unclear	**6/9 Mod**
Traissac [17] (DZA/TUN)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	**8/9 High**
Bencharif [36] (DZA)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	**8/9 High**
El Ati [16] (TUN)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	**9/9 High**
Gualdi-Russo [23] (MAR)	? Unclear	✓ Low	? Unclear	✓ Low	✓ Low	✓ Low	✓ Low	? Unclear	**5/9 Mod**
El Haloui [30] (MAR)	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	✓ Low	? Unclear	✓ Low	**7/9 High**

JBI Critical Appraisal Checklist domains for selected key studies. ✓ = Low risk (green); ? = Unclear/not reported (amber); ✗ = High risk (red). Domains: (1) Sampling frame; (2) Participant recruitment; (3) Sample size adequacy; (4) Subjects/setting description; (5) Data collection coverage; (6) BMI measurement validity; (7) Reliability of BMI measurement; (8) Appropriate statistical analysis; (9) Confounders identified. Full assessment for all 34 studies available on request.

Publication bias: Visual inspection of the funnel plot revealed mild asymmetry. Egger's regression: t = 2.14 (p = 0.041), indicating significant small-study effects. Trim-and-fill analysis estimated three potentially missing studies on the left side of the funnel; adjusted pooled obesity estimate: 32.4% (95% CI: 27.8 - 37.2%). Sensitivity analysis excluding high-risk-of-bias studies (n = 2 excluded) yielded a pooled obesity estimate of 33.2% (95% CI: 28.4 - 38.2%), confirming robustness of main findings.

Table 4: Synthesis of risk and protective factors for obesity across North Africa (2018 - 2026)

Category	Factor	Direction	Countries	Evidence strength	Key studies
Demographic	Female	↑ Risk (consistent)	All five	★★★★★ Very High	**15, 16, 18, 20**
Demographic	Age 40-59 years	↑ Risk (consistent)	All five	★★★★★ Very High	**14, 18, 28**
Geographic	Urban residence	↑ Risk	All five	★★★★ High	**15, 16, 18**
Socioeconomic	Higher wealth/ income (women)	↑ Risk (LMICs)	EGY, MAR, TUN	★★★★ High	**14, 23**
Socioeconomic	Lower educational level	↑ Risk (women)	EGY, TUN, DZA	★★★ Moderate	**14, 15**
Socioeconomic	Housewife / unemployed status	↑ Risk	TUN, DZA, MAR	★★★ Moderate	**15, 16**
Behavioral	Physical inactivity	↑ Risk (consistent)	All five	★★★★★ Very High	**11, 21, 28**
Behavioral	Fast food / sugar-sweetened beverages	↑ Risk	LBY, MAR, EGY	★★★★ High	**4, 21**

Category	Factor	Direction	Countries	Evidence strength	Key studies
Behavioral	Smoking	↓ Inverse association	EGY, TUN, DZA	★★★ Moderate	**8 Bencharif 2022**
Physiological	Multiparity / high parity	↑ Risk (women)	EGY, MAR, TUN	★★★ Moderate	**14, 29**
Policy/Structural	Nutrition transition / dietary westernization	↑ Driving force	All five	★★★★★ Very High	**22**

Evidence strength ratings: ★★★★★ = Very strong (≥ 5 studies, consistent direction); ★★★★ = Strong (3 - 4 studies); ★★★ = Moderate (2 - 3 studies, some inconsistency); ★★ = Weak (1 - 2 studies). SSB = sugar-sweetened beverages; LMICs = Low- and middle-income countries. EGY = Egypt; LBY = Libya; TUN = Tunisia; DZA = Algeria; MAR = Morocco.

Discussion

This systematic review and meta-analysis provide the most comprehensive and methodologically rigorous synthesis to date of adult obesity and overweight prevalence in the five North African nations for 2018 - 2026. The core finding is alarming: one in three North African adults (33.7%, 95.0% CI: 28.9 - 38.7%) meets the WHO definition of obesity, and when overweight is included, a clear majority of adults in Libya (75.3%) and Egypt (74.2%) are affected. These findings are comparable to, or exceed, obesity rates in many high-income countries and represent a dramatic acceleration from estimates only two decades prior [1, 19]. Egypt's national hepatitis C screening programme (2018 - 2019), involving 49.6 million individuals, recorded an obesity prevalence of 39.8% - surpassing many GCC countries previously considered the obesity epicenters of the region [10]. They translated this prevalence into about 115,000 annual deaths and 19.0% of total Egyptian annual mortality attributable to high BMI [10].

The nutrition transition framework: The findings are consistent with the nutrition transition model, in which economically developing nations shift from traditional plant-based dietary patterns toward high-calorie, high-fat, high-sugar diets while simultaneously reducing physical activity due to urbanization and motorization [20]. All five countries have undergone this transition at varying speeds. Libya, experiencing significant political instability since 2011, has paradoxically seen continued deterioration in dietary quality and reduced access to structured physical activity environments [21]. The Mediterranean diet - historically a protective factor - has declined in adherence across all five countries, with increasing consumption of ultra-processed foods and sugar-sweetened beverages, particularly among younger and urban populations [22, 23].

Gender inequality and obesity: The consistent and substantial gender gap in obesity (pooled F: M ratio = 1.98) has major implications for public health programming. In Tunisia, the gap is most extreme (F: M = 2.78), with approximately 37.0% of women versus 13.3% of men classified as obese [16]. Multiple interacting mechanisms explain this disparity: cultural restrictions on female physical activity, normalization of female obesity as a marker of prosperity and fertility in several cultural contexts, cumulative weight gain from frequent pregnancies and incomplete postpartum weight loss, and limited access to education, employment, and financial autonomy for women in several of these countries [15, 24].

Urban-rural and socioeconomic gradients: Urban obesity consistently exceeded rural prevalence across all reporting countries, though the gap has been narrowing as rural populations progressively adopt urban dietary patterns - a phenomenon accelerated by mobile internet penetration, rural-to-urban migration, and mechanization of agriculture reducing physical labor demand [6, 25]. The relationship between socioeconomic status and obesity in North Africa differs from high-income country patterns; more recent data suggest the positive SES-obesity association is reversing as unhealthy food becomes more affordable and accessible across all economic strata - the "obesity paradox of development" [26].

Heterogeneity, limitations, and research gaps: The high between-study heterogeneity (I^2 = 91.4%) reflects genuine epidemiological diversity across five countries with different economic development levels,

healthcare systems, cultural practices, and epidemiological stages. Key limitations of the evidence base: (i) paucity of nationally representative data for Libya and Algeria specifically for 2020 - 2026; (ii) reliance on modelled estimates for some country-year combinations; (iii) exclusion of non-BMI obesity measures (waist circumference, body fat percentage); (iv) limited data disaggregated by ethnicity, disability, or migrant status; (v) near-complete absence of longitudinal trend data for Algeria and Libya within 2018 - 2026. The COVID-19 pandemic period (2020 - 2022) remains particularly under-studied regarding its impact on obesity trajectories [26].

Policy implications: The findings carry direct policy relevance at national and regional levels. First, the near-universal absence of comprehensive national obesity prevention strategies with measurable targets must be urgently addressed [28]. Second, the disproportionate burden in women demands gender-responsive interventions addressing structural barriers to physical activity and healthy nutrition, rather than approaches placing responsibility solely on individual behavior change. Third, primary healthcare systems must integrate routine BMI assessment, counselling, and weight management referral into all adult consultations [38]. Fourth, taxation of sugar-sweetened beverages, restriction of unhealthy food marketing, mandatory food reformulation, and urban planning promoting active transport should be prioritized. Finally, investment in standardized national obesity surveillance using the WHO STEPS protocol, harmonized cross-nationally, is essential for future evidence-based policy-making.

Recommendations: Future research must prioritize nationally representative, gender- and age-disaggregated prevalence studies using measured anthropometry in all five countries, harmonized longitudinal surveillance to track post COVID-19 trends, and evaluation of the effectiveness of specific interventions in the North African context. Regional collaboration between health ministries, WHO EMRO, and academic institutions is essential to build a coordinated, evidence-based response to what is now the most prevalent non-communicable disease risk condition in North Africa.

Conclusion: This PRISMA 2020-compliant systematic review and meta-analysis establishes that overweight and obesity have reached epidemic proportions across all five North African countries studied, with a pooled adult obesity prevalence of 33.7% (95% CI: 28.9 - 38.7%) and a combined overweight plus obesity prevalence exceeding 60.0% - 75.0% in the most affected nations. The epidemic disproportionately burdens women, urban residents, and individuals aged 40 - 59 years. Key drivers include the nutrition transition, physical inactivity, gender-based inequities, and urbanization. The evidence base remains critically sparse for Libya and Algeria in the 2020 - 2026 period.

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